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Analysis of Underwater *Odobenus* Calls with Remarks on the Development and Function of the Pharyngeal Pouches[1,2]

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(Plates I-V; Phonograph Disk)

WE HERE report underwater sounds made by a 10-year-old Atlantic walrus (NYA No. 1: "Olaf"), *Odobenus r. rosmarus* (Linné) 1758, captive at the New York Aquarium since a little over a year of age. We distinguish three categories. Most often heard is a short, rasping sound, next are series of clicks, and rarest is a striking bell-like sound. These are all true underwater sounds, made with the mouth shut and the head submerged. Examples of each are given on the accompanying phonograph disk. The familiar in-air bellow, grunt, and mellow whistle couple well with water when made by a partially immersed animal, but are not discussed here.

The rasps and clicks are evidently usual underwater sounds of walrus. We have heard and recorded them on several occasions since 1963. The bell-like sounds are made less frequently and appear to be associated with the development of the pharyngeal pouches.

Material and Methods

The pool in which the walrus was confined is 21 x 12 m and 2.5 m in depth, and cement and glass lined. The walrus shares the pool with three grey seals, *Halichoerus grypus* (Fabricius) 1791, which were not in the water when the recordings here analyzed were made in March 1965 by Ray, using an LC-50 (Atlantic Research) hydrophone, a transistor pre-amplifier and a Nagra III B tape recorder. Analysis playback was by means of a Crown (B 800 series) recorder. The entire system was essentially flat from 50 to 10,000 cps. The spectographic analyses were made on a Kay Electric Vibralyzer.

Results

The rasps and clicks have some features in common. The rasp begins with 4 to 10 pulses emphasizing a frequency between 400 to 600 cps, about 0.01 second apart. As the call progresses, both intensity and repetition rate increase, producing a nearly continuous sound with harmonic structure and an apparent base frequency of 200 to 300 cps. The whole event is over in 0.1 to 0.2 second. Plate I gives an example.

The clicks or pulses, Plate II, resemble the rasps in acoustic structure, although they sound very different to the listener. Each click is an

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entity lasting 0.015 to 0.020 second, and with an appreciable pause before the following click, 10-per-second being the highest repetition rate that we have noted. Like the rasp, the clicks have a base frequency near 400 cps, but with a sharp front. They exhibit other frequencies and may have harmonics as high as 10,000 cps. The base frequency is not always the most intense. The listener notes a metallic resonance in some of these clicks, usually the latter ones of a series. in the band from 500 to 1500 cps.

The most striking of the walrus sounds is the "bell." Although well known to the Eskimo, it is not conspicuous in the literature; we have found only two references (Brooks, 1954, and Fay, 1960). This sound is clearly audible in the air and has been heard only when the animal is partially or shallowly submerged or, rarely, out of water. Here we discuss the sounds as heard underwater. At the time, the walrus was floating at the surface with his head hanging down. The bell sound lasts 1 to 1.5 seconds, decaying gradually. As in an actual bell, the subsidiary frequencies and harmonics die out, leaving the fundamental ringing. Our animal's fundamentals ranged from 400 to 1200 cps. The analyses show that there are two "bells" involved, sometimes differing in fundamental frequency by as much as about 400 cps. This difference may vary from call to call; in one instance, calls 1.5 seconds apart emphasized first the lower frequency, which happened to be 850 cps, and then the higher, 1200 cps. In Plate III, the first of the two calls shows such a double frequency (about 50 cps apart). We presume that this tone variation is under the animal's control, as particularly indicated in the glissando of some of the second group of "bells" in the phonograph record; this implies changing pressure or volume in the air-filled pouch. Each "bell" begins with a transient pulse much like the click described above, which seems to be the exciter or striking of the "bell."

Discussion

Clues to the use to which *Odobenus* puts these sounds may be derived from the behavior and anatomy of the captive recorded here. Its right eye is shrunken and its left cornea is scarred, and therefore we believe that its vision is impaired. Yet the animal, often swimming with eyes closed, experienced no orientation difficulties. It emitted only the rasps and clicks while swimming; perhaps this may have been echo-location, but since the walrus was in very familiar uncluttered surroundings, it may have been depending on memory for orientation.

The bell-like sound is closely associated with sexual activity in this animal, for instance when the walrus is floating head down and indulging in masturbation, Plate IV, or during coition, Plate V, sometimes with young female walrus and sometimes with male or female *Halichoerus* as partners. The pharyngeal pouches first became evident at five years of age. Their use, especially during sex play, increased as the pouches gained in size. The bell-like tone was first noted at seven years of age, when Olaf was copulating with a young female walrus out of water. In that instance, the sound was made in air, though with mouth and nostrils closed.

Fay (1960, p. 369) notes that the St. Lawrence Islanders and the people of Barrow relate these "bells" to the paired inflatable pharyngeal pouches which are variously and not always symmetrically developed. As Fay points out, they have generally been called oesophageal expansions, but Brooks and Fay specify that they are pharyngeal diverticula. They are not developed in young animals and some females, and attain maximum size in males, sometimes extending nearly to the posterior border of the thoracic cavity, with a capacity as great as 25 and even over 50 liters (Fay 1960, p. 363). In the captive described here it is about 30 liters, as estimated from the measurements on the living animal (pouch estimated 60 cm long, 45 cm wide, 20 cm high). The pouches are capable of being individually inflated, Plate IV.

We have, quite by accident, confirmed that these pouches act as resonators for the "bell." During an Eskimo walrus hunt with Ray present in May, 1963, an adult male walrus was shot while resting on ice; it died almost immediately with one pharyngeal pouch inflated. The skin and fat were removed laterad to the pouch, exposing it. When it was struck with the flat of a knife blade, a bell-like tone almost identical to that recorded was produced.

Both Sleptzov, 1940, (who says that the pouches are symmetrical in embryos, but asymmetrical in adults) and Fay, 1960, favor adjustment of buoyancy during rest and sleep in water as the pouches' primary function. We suggest that the pouches are a secondary sexual characteristic, used for both sound production and flotation during courtship and coition, as seen in our captive. Flotation during rest would be useful, as well.

The reported asymmetry of these pouches offers a possible explanation of the two variable tones that we have noted. The rapid changes imply subtle muscular and pneumatic control. One would expect tone differences between different individuals, and perhaps on different occasions. We note that our subject is an Atlantic walrus of the typical subspecies, which in this

trait at least does not seem to differ from *O. r. divergens* (Illiger) 1815 from Alaskan waters. Sleptzov, 1940, describes a "swim-bladder" tracheal dextral diverticulum in males of *Histriophoca fasciata,* and alludes to less pronounced developments in *Eumetopias jubata, Erignathus barbatus, Phoca vitulina largha,* and *Phoca (Pusa) hispida.* Perhaps some special sounds may be listened to from these species.

Summary

Three underwater calls of a captive *Odobenus* are described and analyzed: rasps (lasting 0.1 to 0.2 second, with emphasis between 200 and 600 cps), clicks (lasting 0.015 to 0.020 second at repetition rates up to 10 per second, with a base frequency near 400 cps), and bell-like tones (lasting 1 to 1.5 seconds with fundamentals ranging from 400 to 1200 cps). The bell-like tone is associated with the development of the pharyngeal pouches and is used during courtship and coitus.

References

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EXPLANATION OF PLATES

Plate I

The rasp was the most common underwater sound heard from the walrus. A 240 cps bandwidth filter was used in analysis.

Plate II

The underwater clicks of the walrus often have a metallic sound. The analyzing filter bandwidth was 240 cps.

Plate III

The bell-like sound of the walrus has a long, slowly decaying resonance. The analyzing filter used here had a 12 cps bandwidth.

Plate IV

"Olaf," 6 years old, with right pharyngeal pouch inflated.

Plate V

"Olaf," 7 years old, during coition with a 1-year-old Pacific walrus. Bell sounds were made at the time.

Inserted

Phonograph disk of underwater calls of captive (Olaf).